



Effects of Reduced and Hyper Gravity on Functional Near-Infrared Spectroscopy (fNIRS) Instrumentation

Problem Statement

- fNIRS quantifies neural activations in the cortex by measuring hemoglobin concentration changes via optical intensity. This depends on probe-skin coupling which is highly susceptible to motion.
- The lack of reliable and self-applicable headgear robust to the influence of motion artifact blocks its operational use in aerospace environments. It is difficult to separate changes due to functional activation from changes due to motion.
- Both NASA's Aviation Safety and Human Research Programs may be potential users of this technology.

Technology Development Team

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Proposed Flight Experiment

Experiment Readiness:

- the experiment will be ready to meet deadlines for flight in September, 2012.

Test Vehicles:

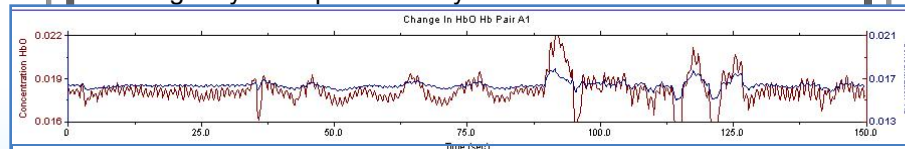
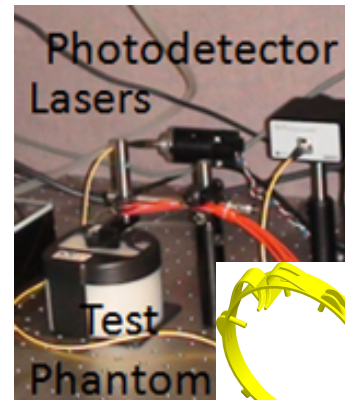
- 727 parabolic aircraft

Test Environment:

- The experiment has not previously flown in micro-gravity environments.
- We request microgravity conditions. Martian, lunar and 1.5g conditions desired.

Test Apparatus Description:

- Laser light will be delivered to and collected from optically scattering phantom material via optical fibers held in place by headbands mounted on the test material (pictured above - two probes per headband). Optical and electrical components will be mounted on a breadboard bolted to a rig (previously flown).
- A pressure sensor at one probe, and photodetectors at the bilateral probe, will be used to collect data throughout changes in the mechanical environment and microgravity conditions, for various headgear strap tensions.
- Operator interface will be via laptop computer for data collection, and will require adjustment and reconfiguration to achieve test matrix objectives during some high-g portions of the flight by an experienced flyer.



hemoglobin concentrations dominated by motion artifact

Technology Maturation

- the headgear is TRL 4 in 2012
- to achieve TRL 5 in 2013:
 - iterate and expand headgear prototypes and data processing with 2012 flights
- advance electronics to provide frequency-domain fNIRS
- collect functional data in a relevant aviation microgravity environment with human subjects performing an attentional task
- plan to achieve TRL 6 in 2014 with subsequent integration into a more complex cognitive state predicting system.

Objective of Proposed Experiment

- These flights aim to inform headgear design and data processing methods, and verify instrumentation to prepare for IRB approval for future human subject tests.
- The flight data will include dynamic optical and mechanical measurements. Characterization of mechanical contributions to the optical signals will allow the determination of headgear design parameters to minimize contamination, while allowing their identification and removal.